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ABSTRACT

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COLLABORATIVE LEARNING IN A VIRTUAL CLASSROOM: HIGHLIGHTS OF FINDINGS

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ABSTRACT

Software to support teaching and learning activities was added to a computer-mediated communication system to create a "Virtual Classroom." Goals included improving access to and the effectiveness of college-level courses, particularly by facilitating collaborative learning. Process and outcomes were compared for sections of several courses taught in the traditional classroom, totally online, or in mixed mode. On the average, students report that the Virtual Classroom provides a better learning experience.

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COLLABORATIVE LEARNING IN A VIRTUAL CLASSROOM

INTRODUCTION

A "Virtual Classroom" [TM] is a teaching and learning environment located within a computer-mediated communication system (CMCS). Rather than being built of bricks and boards, it consists of a set of group communication and work "spaces" and facilities which are constructed in software. The objectives of a Virtual Classroom are to improve access to advanced educational experiences by allowing students and instructors to participate in remote learning communities, using personal computers at home, on a campus, or at work, and to improve the quality and effectiveness of education by using the computer to support a collaborative learning process. Collaborative learning is defined as a learning process that emphasizes group or cooperative efforts among faculty and students, active participation and interaction on the part of both students and instructors, and knowledge that emerges from an active dialogue among those participants sharing their ideas and information (see Bouton and Garth, 1983; Whipple, 1987).

Teaching and learning in a "class" can be thought of as a type of collaborative or cooperative work process. The task of the work group is to help one another learn a set of concepts oand? or skills, such as how to mannage an organization, or how to produce a complicated program as a team project. Studies about the use of CMC facilities which form components of a "Virtual Classroom" environment, have tended to support the point of view that for mature, motivated learners this mode of learning can be more interactive and more effective than the

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traditional (physical) classroom (see Welsch, 1982; Quinn, et. al., 1983; Davie and Palmer, 1984; Hiltz, 1986a, 1986b; Harasim, 1987).

Major funding from the Annenberg/CPB Project enabled NJIT to develop an initial set of "Tools for the Enhancement and Evaluation of a Virtual Classroom," using the "interact" language developed for constructing prototypes within its current "laboratory without walls," EIES (the Electronic Information Exchange System; see Turoff and Hiltz,1981). Equally important to the project has been the evaluation of educational outcomes in the Virtual Classroom. The basic strategy has been a quasi-experimental design that matches sections of the same course, with the same instructor, text, and examinations, which are conducted in the traditional and Virtual Classroom settings. This paper presents a brief overview of the project and of its major findings. Complete results are contained in a two-volume final evaluation report (Hiltz, 1988a, 1988b).

THE CONCEPT OF COLLABORATIVE LEARNING

CMC is particularly suited to the implementation of collaborative learning strategies or approaches. Literally defined, the act of collaborating means to work together (co-labor). Collaborative learning means that both teachers and learners are active participants in the learning process. And, knowledge is not something that is "delivered" to students in this process, but rather something that emerges from active dialogue among those who seek to understand and to apply concepts and techniques. In the collaborative learning model:

> Education does not consist merely of "pouring" facts from the teacher to the students as though they were glasses to be filled with some form of intellectual orange juice. Knowledge is an interactive process, not an accumulation of Trivial Pursuit answers; education at its best develops the students' abilities to learn for themselves... Collaborative activities lead to emergent knowledge, which is the result of interaction between (not summation of) the understandings of those who contribute to its formation (Whipple, 1987, p. 5).

Collaborative or group learning has been given many labels in the educational literature, including "cooperative learning, collective learning, study circles, team learning..." (Bouton and Garth, 1983, p. 2), and "peer-group learning" or "syndicates" (Collier, 1980). The various forms include a process of group conversation and activity, that is guided by a faculty member who structures tasks and activities and offers expertise. Its basic premise is that learning involves the "active construction" of knowledge by putting new ideas into words and receiving the reactions of others to those formulations (Johnson and Johnson, 1975). This is the pedagogical approach which the instructors in this project tried to incorporate into their online classes.

Most courses in this project included one or more "seminar" type segments in which the students became the teachers; this was the most pervasive form of colloborative learning strategy. Individual or small groups of students were responsible for reading material not assigned to the rest of the class, preparing a written summary of the material for the rest of the class, and leading a discussion of the topic or material for which they were responsible. The seminar format is generally restricted to small classes of very advanced students in a face-to-face situation, primarily because it is too time consuming to have many students doing major presentations. Secondly, less advanced students often feel very embarassed and do not present material well in an oral report to their peers; and are even worse at playing the role of the teacher to moderate a discussion. In the written mode, they can take as long as they need to polish their presentations. Hence, the quality of their work and ideas is what comes through, not their public speaking skills. Other students can read material in a much shorter time than it would take to sit through oral presentations. If the material is poorly presented, they can hit the "break" key, whereas etiquette dictates that they must sit and suffer through a poor student presentation in the face-to-face situation. In addition it it appears to be easier for students to "play the role" of teacher in this medium, which is more equalitarian than face-to-face communication. Seminar-style presentations and discussions are, thus, an example of a collaborative learning activity which is often difficult in the traditional classroom, but which tends to work very well in the Virtual Classroom environment, even with fairly large classes of undergraduates.

Other examples of collaborative learning activities in the Virtual

classroom included group programming projects in the Introduction to Computer Science course, and role-playing simulations in courses in French and Management. In the "Virtual Management Laboratory" in the latter course, students simulated organizational activities over a fiscal year in competing "corporations," including the development of a product plan, marketing plan, financial plan, and human resources management plan. In a freshman level writing course, first drafts of assignments were presented to a peer group using a "pen-name", and the students were graded partially on the quality and amount of suggestions they offered to one another for improving their drafts.

Collier (1980) summarized many reports of an increased involvement of students in their courses as a result of group learning structures, including better class attendance (reported by Field, 1973); greater expenditure of time on the work outside of class (Collier, 1966; Rudduck, 1978); greater satisfaction with the course (Beach, 1974; Goldschmid & Goldschmid, 1976) and an increased wish to pursue subsequent studies on the topic (Beach, 1974). Collier also noted that although most reports show "no difference" between courses based on small-group discussion and courses based on lectures and other more traditional modes of instruction (e.g., Costin, 1972), there are some documented cases in which knowledge gained by students was greater in the small-group setting (e.g., Blunt & Blizzard, 1973; Erskine & Tomkin, 1963; Clement, 1971). Finally, many reports support the premise that group learning enhances "higher-order" intellectual skills, such as the application of learned principles in fresh situations, critical thinking, and the synthesis of diverse materials (Clement, 1971; Costin, 1972; Rudduck, 1978; Abercrombie, 1979).

SOFTWARE TOOLS FOR A VIRTUAL CLASSROOM

A variety of educational institutions are using simple message systems (e.g., Welsh, 1982; Quinn, et. al., 1983) or existing conferencing systems to supplement traditional delivery modes or to totally conduct a course. Particularly notable are efforts by Harasim and her colleagues (Harasim, 1986, 1987; Harasim and Johnson, 1986; Davie, 1987) using PARTIcipate at the Ontario Institute; of Deutshman and Richards and their colleagues, also using PARTICIpate, at NYIT (e.g., Haile and Richards, 1984); of McCreary and her colleagues at Guelph, using COSY (McCreary and Van Duren, 1987); and of Nipper and his colleagues, using COM in Denmark (Nipper, 1987).

Electronic mail has been used in an "adjunct" mode to support classes delivered primarily via other media. For instance, Welsh (1982) reported that electronic mail led to a much more "interactive" class. Even grading became interactive, with the students arguing for better grades on specific papers and making iterative changes to their assignments. Quinn et. al. (1983) also documented a "higher proportion of student turns to teacher turns" in messages exchanged via computer than in the face-to-face classroom. In addition, content analysis showed that the length of responses by students was much longer in computer-mediated communication. These observations about changes in the balance and nature of interaction among the instructor and the class members were also documented in pilot studies of earlier online courses on EIES (Hiltz, 1986a).

Our own pilot studies were based on using the standard EIES software to supplement traditional courses or to deliver non-credit continuing education courses. Though the results were promising, it was evident that there were many limitations to be overcome, particularly for standard college-level courses that required numerous assignments and examinations as part of the course work. Conceptually, we divided these into a set of structures called Branch Activities which could be attached to a class conference to support special types of assignments or delivery of material for activities that were to involve the whole class; a set of teaching support tools to help the instructor manage assignments and grading and quizzes for individual students; and micro-computer based software for the integration of graphical information with text information.

An "activity" is an executable program rather than ordinary text. For example, initial activity types included the reading of long documents, examinations, conditional question and response delivery, and the selection of choices from a list (see Hiltz, 1986c for details on this special software). Instructional management tools included an electronic gradebook and routines to collect and track assignments (see Gleason, 1987). Another major tool is "Personal TEIES," which allows the composition, display, and storage of mixed text and graphics elements. Transmission through a conferencing system in NAPLPS encoding makes the graphical compositions, device-independent in terms of allowing composition and display on different types of micros (see Foster, 1987). The Virtual Classroom software tools to support collaborative learning are now being incorporated into a new system

(TEIES, the Tailorable Electronic Information Exchange System), which operates on IBM mainframes, and will be distributed to other organizations.

EVALUATION GOALS AND PROCEDURES

The evaluation objectives were to describe the nature of the educational experiences and outcomes in this delivery mode; to compare them to the traditional (physical) classroom; and to determine those conditions associated with good or poor outcomes. In order to explore these questions, it was necessary to observe a variety of courses, students, and implementation environments. The primary research design rested upon matched, but "non-equivalent" sections of the same course taught online and in the traditional classroom. Though the same teacher, text and other printed materials, and midterm and final exams were used, the classes are "non-equivalent" because the students were able to self-select delivery mode. The matched courses included Introductory Sociology at Upsala College (Soc 150); freshman-level Computer-Assisted Statistics at Upsala (CC140y); Introduction to Computer Science (CIS213) at NJIT; and an upper-level introductory course in statistics for engineers at NJIT (Math 305, Statistics for Technology). The two colleges provided very different implementation environments. Upsala is a small liberal arts-oriented college with one microcomputer laboratory and little prior integration of computing into the curriculum; NJIT is a technological university where for the last three years, incoming freshmen have been issued IBM-PC compatible microcomputers to take home, and computers are used in all freshman-level courses.

In addition, some courses were taught with mixed modes of delivery (partially online and partially face-to-face). The proportion of the total course which took place in the Virtual Classroom in "mixed" mode was usually about 50%, meaning that a course would meet about half of the normally scheduled hours face-to-face and carry out about half of the total class activities online. However, the "mix" varied from approximately 25% online to approximately 75% online. For the purposes of this study, however, even the totally online courses were required to meet for one orientation session (when pre-course questionnaires were distributed) and for the midterm examination and the final examination (when post-course questionnaires were collected).

Mixed-modes courses included the extensive laboratory component of NJIT's introductory management course (OSS 471), which for both semesters had one section that conducted its management laboratory exercises in the traditional manner (offline), and one which used the VC as a "Virtual Management Laboratory." Other courses that used VC in a mixed or adjunct mode included Organizational Communication, a Freshman Writing Seminar, an Anthropology course on North American Indians, and a course in Business French (all at Upsala). All together, we collected data from a total of 132 students in completely online courses, 96 in mixed mode courses, and 89 in traditional or "control" courses.

Most of the data used in the study were collected with a pre and post-course questionnaire. However, we also have behavioral data (including grades and SAT scores, when appropriate or available, and amount and type of online activity), and qualitative observations and interviews.

This paper will present only a summary of the hypotheses and findings, concentrating on student perceptions of whether or not the VC mode does support collaborative learning, and whether it is more effective as a learning mode than the traditional classroom.

STUDENT PERCEPTIONS OF THE VIRTUAL CLASSROOM

The post-course questionnaire asked all students participating in the Virtual Classroom to compare their experiences to previous "face-to-face" classroom courses. These questions were 1 to 7 Likert-type scales, with responses ranging from "strongly agree" to "strongly disagree." The responses from 1 to 3 were totalled as indicating agreement, and those from 5 through 7 as indicating disagreement. In this section, we will review in more detail, some of the key items drawing from personal interviews the kinds of experiential detail that underlie the ratings distributions.

Convenience: The majority (65%) feel that taking online courses is more convenient. Even those students who generally preferred traditional courses tended to comment on the advantages of being able to work on the course at times of their own choosing. For instance, a student from the fall Statistics course at Upsala comments,

> I liked that I was independent and that I could go whenever I wanted to. And I like how the conferences were written down and I could get my notes. It also helps if you miss a day or two, because the computer always has your assignments there for you.

Those with computers and modems at home were most likely to appreciate the convenience. For example a Management Lab student says,

> It's also good because there is easy access whenever you want. I have a modem at home. I can go on at 3 o'clock in the morning. That's usually when I do most of my work.

Themes related to the greater convenience and comfort of attending class online also appear in the comments offered by students about what they "liked best" about the Virtual Classroom. "Being able to do the assignments at my own pace and not being obligated to sit in a very confined classroom;" "the freedom;" "being able to put the information into the computer whenever it is convenient;" "flexible class hours," and "not having to go to class" are some of the attributes mentioned.

Increased Interest, Involvement, and Motivation: For those who participated regularly, the level of interest and involvement tended to be high. Overall, 55% agreed that the fact that their comments would be read by other students increased their motivation. 62% disagreed that the Virtual Classroom was "more boring" than traditional classes, and 56% agreed that they felt more involved in taking an active part in the course. The word "fun" is frequently used by those students who reported high levels of involvement.

Increased Interaction: The majority of students (58%) felt that they had better access to their professor in the Virtual Classroom. This interaction was also more "friendly" and equalitarian than the typical interaction in the traditional classroom in most cases. For example, a Math 305 student says

> She'll put a message in and say, "Have a great week..." Especially, if you have a message or a problem, she'll write back and say, "Hi there, how have you been? You have a problem with this..." It's really almost like talking on the phone. I try to send messages back the same way, real casual. It's not a strict teacher-student kind of thing. Because of her, you feel a lot closer, because it's so easy just to pop a question. She'll answer the next day, or whenever you come online.

Opinion was more mixed about whether the Virtual Classroom led to more communication with other students in the class: 47% agree, but 19% perceive no difference between the delivery modes on this criterion, and 32% disagree. On related questions, 59% found that the comments made by other students were useful; and 62% found that reading the reviews or assignments of other students was useful.

Those who were most enthusiastic about the medium tended to value the contributions and comments of other students highly, and enjoyed reading them. Among the phrases that are used in describing what students "like best" about the Virtual Classroom are "Class participation," "Being in touch with other students constantly," "Working as a group and extended communications online," and "The openness- I liked to hear other students' ideas." A Math 305 student reported that the comments of other students were

> ...entertaining. Some of those people have some witty comments. That makes the class more interesting. If you find that there are a lot of comments, then you get online just to see them.

By contrast, a negative student in the same course commented, "I usually just blew off the other class members' comments and went straight to the professor's lectures." A negative student in the Upsala statistics course refused to read anything written by students, and referred to student contributions as "junk." A classmate in the same course reported, however,

> Most of the students who made comments were the ones who really understood the class and they were about the lectures. And they were pretty helpful, especially when the homework could be checked.

An Organizational Communication student commented as follows about the value of reading the comments of other students:

> I felt that they were really helpful. It gave me another perspective on what I was doing. If I did not see a point and they did, I was able to incorporate it into my thinking... It was really a good way of learning different ideas.

SUMMARY OF FINDINGS

Despite many implementation problems, including active resistance from many faculty members to allowing this experiment to proceed on their campus, the results of this field trial are generally positive, in terms of supporting the conclusion that the

Virtual Classroom mode of delivery can increase access to and the effectiveness of college-level education.

The following is a summary of some of the major hypotheses and findings. Originally, there was an hypothesis that the mixed mode results would not simply represent an "average" of the Virtual Classroom (VC) and Traditional Classroom (TC) modes, but might have some unique advantages and disadvantages. In the following summary, results related to this speculation are included in reviewing each of the other hypotheses.

H1: There will be no significant differences in scores measuring MASTERY of material taught in the virtual and traditional classrooms.

Finding: No consistent differences. In one of five courses, VC final grades were significantly better.

This hypothesis was tested using a quasi-experimental design which compared the midterm exam scores, final exam scores, and final grades attained by students in matched sections of five courses. In Computer Science, student performance tended to be significantly better, on the average, as measured by grades. Though there are no statistically significant differences for the two Freshman level courses in Sociology and Statistics, these were courses in which many students did D or F work in both modes, and the instructors tended to feel that the mode further disadvantaged young, poorly motivated students with marginal levels of reading, writing, and quantitative skills.

H2: VC students will perceive it to be superior to the TC on a number of dimensions:

2.1 CONVENIENT ACCESS to educational experiences (supported).

2.2 Increased PARTICIPATION in a course (supported).

2.3 Improved ability to apply the material of the course in new contexts and EXPRESS their own independent IDEAS relating to the material.

Finding: Increased confidence in expressing ideas was most likely to occur in the mixed modes courses.

2.4 Improved ACCESS to their PROFESSOR (supported).

2.5 Increased level of INTEREST in the subject matter, which may carry beyond the end of the course.

Finding: This is course dependent. Though the averages for measures of increased interest are higher for both the VC and Mixed modes, the overall scores are not significantly different. Interest Index scores are highest for the VC mode at NJIT and for the Mixed mode courses at Upsala.

2.6 Improved ability to SYNTHESIZE or "see connection among diverse ideas and information."

Finding: No significant differences overall; mode interacts with course.

2.7 COMPUTER COMFORT- improved attitudes toward the use of computers and greater knowledge of the use of computers (supported).

2.8 Improved ability to communicate with and cooperate with other students in doing classwork (Group COLLABORATION Skills).

Findings: Mixed and course-dependent. Though 47% of all students in VC and Mixed modes courses felt that they had communicated more with other students than in traditional courses, 33% disagreed. The extent of collaborative learning was highest in the Mixed-mode courses.

2.9 Improved Overall QUALITY, whereby the student assesses the experience as being "better" than the TC in some way, involving learning more on the whole or getting more out of the course (supported).

Though the "average" results supported most of the above predictions, there was a great deal of variation, particularly among courses. Generally, whether or not the above outcomes occur is dependent more on variations among courses than on variations among modes of delivery. The totally online upper level courses at NJIT, the courses offered to remote students, and the mixed mode courses were most likely to result in student perceptions of the Virtual Classroom being "better" in any of these senses.

H3: Those students who experience "group learning" in the Virtual Classroom are most likely to judge the outcomes of online courses to be superior to the outcomes of traditional courses.

Finding: Supported by both correlational analysis of survey data and qualitative data from individual interviews. Those students who experienced high levels of communication with other students and with their professor (who participated in a "group learning" approach to their coursework) were most likely to judge the outcomes of VC courses to be superior to those of traditionally delivered courses.

Qualitative Outcomes

In many cases, results of the quantitative analysis are inconclusive in determining which is "better," the VC mode or the TC mode. The overall answer is, "it depends." Results are superior for well-motivated and well-prepared students who have adequate access to the necessary equipment and who take advantage of the opportunities provided for increased interaction with their professor and with other students, and for active participation in a course. Students lacking the necessary basic skills and self-discipline will do better in a traditionally delivered course. Whether or not the VC mode is "better" also depends crucially on the extent to which the instructor is able to build and sustain a cooperative, collaborative learning group; it takes new types of skills to teach in this new way (Hiltz, 1988b).

The "verdict" on Virtual Classroom comes down, in the end, to the qualitative reactions of students and instructors who were stimulated by this new type of learning environment. For example, here is the text of a message from a student in the Management Laboratory, sent after the course was (officially) over:

> Roxanne, I just completed Enrico's 471 class here on EIES. I felt that I should give you what I feel about the class and what it has done. It was the most stimulating, fascinating, educational and social experience I have ever had! From the subject itself to how it was presented to the activity and enthusiasm of this class, it was beyond words...
>
> A lot of what happened, the massive activity in the conferences, the massive amount of time spent online by each participant, and the new, good and lasting friendships that developed (AND THERE ARE A LOT OF THOSE) will never be given justice in whatever the results of this project are, but they are what was really meaningful in this course. A great deal of learning was accomplished concerning the topic and a lot of other ideas. Learning that would not have been so great and varied as it was (without the system).
>
> I am not the only person who feels this way; its shared by most of the class...
>
> I have never dreaded so much the end of a semester and I hope that the group that formed and its cohesiveness that was so strong will continue afterwards. I don't want to belabor the point, but do want to emphasize what a great thing it was and hope to see it continue for a long time to come because the quality of the educational experience is greatly increased not only for the subject matter, but on a social level as well. Thanks for giving us this chance.

Essentially, that's what the Virtual Classroom software provides-- a chance to participate in a different kind of learning experience, one based on an active learning community working together to explore the subject area of a course. Note that the Management Laboratory was referred to above as "officially" over. A month after the grades had been turned in, the class conference was still active, with over a hundred new entries which continued to discuss the issues raised in the course. This type of behavioral indicator of development of a high level of interest in learning validates the responses of students to questionnaire items.

The VC is not without its disadvantages, and it is not the preferred mode for all students (let alone all faculty). Students (and faculty) report that they have to spend more time on a course taught in this mode than they do on traditional courses. Students also find it more demanding in general, since they are asked to play an active part in the work of the class on a daily basis, rather than just passively taking notes once or twice a week. For students who want to do as little work as possible for a course, the Virtual Classroom tends to be perceived as an imposition rather than an opportunity. The VC is also not recommended for students who are deficient in basic reading, writing, and computational skills.

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